

# The U.S. Army Electronic Proving Ground (EPG) Develops Ground Truth Monitor System

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*In the course of developmental testing, the need arises to provide a real-time verification of signals presented to a system under test (SUT). To test modern communications intelligence systems, the test officer must present a dense radio frequency environment containing a wide variety of signals. In order to present a realistic environment, the emitters must be geographically spread out relative to the SUT. To present this environment, the U.S. Army Electronic Proving Ground (EPG) developed a series of emitter vans, each of which presents a time order event list of radio emissions. The timing of radio emissions is accurately triggered using a Global Positioning System-based clock, and to enhance the test officer's confidence that the correct emissions are indeed occurring at the intended times, the EPG developed the Ground Truth Monitor (GTM). The GTM performs sampling of the radio frequency (RF) environment in the vicinity of the SUT to verify that each of the intended RF emissions is reaching the SUT at the intended RF power level and time. The GTM was installed and has successfully supported recent major test objectives at the Red Tower location at EPG's Antenna Test Facility.*

The U.S. Army Electronic Proving Ground's (EPG's) Antenna Tower Facility (ATF) consists of five main components: the Arc Range, Antenna Tower, two turntables and the Compact Range. The Arc Range, Red Antenna Tower and both turntables were instrumental in the recent major test employing the Ground Truth Monitor (GTM).

The ATF Arc Range (Figure 1) is a laminated wooden arc and has a radius of 75 feet, with a 60-foot, 80-ton capacity turntable centered at its base. The turntable rotates 360 degrees in azimuth to provide a polar or rectangular antenna pattern. Hemispherical measurements can be taken at greater than a single hemisphere cut from -13 to +90 degrees. At the focal point of the arc, a wooden test pedestal (20-foot x 22-foot x 22-foot) can be utilized to hold test vehicles up to 10 tons. The arc facility supports antenna testing from 20 MHz up to 18 GHz.

The Red Antenna Tower (Figure 2) is a 114-foot wooden tower located 500 feet from the

arc. An additional 30-foot turntable capable of holding 60 tons is located another 500 feet further from the arc. The tower, centered between the arc and small turntable, is equipped with antenna sleds on those two sides. The sleds allow elevation of test or measurement antennas between ground level and 100 feet. These assets, in concert with numerous surveyed points forming a semi-circle around the small turntable, provide radio frequency (RF) signal and test item position capabilities for conducting specialized test of direction finding, emitter identification and other RF signal processing systems.

The GTM is a product of EPG's Test Technology Design and Development (T2D2) Lab. The T2D2 Lab, located in the Electromagnetic Environmental Test Facility (Figure 3) provides an advanced technologies development capability. The lab's goal is to enhance the effectiveness of the EPG's test capabilities by synthesizing technologies not commercially available to meet the demanding needs of test officers who are required to test



Figure 1. The EPG Antenna Tower Facility (ATF) Arc Range



Figure 2. The Red Antenna Tower

cutting-edge command, control, communications, computers and intelligence (C<sup>4</sup>I) systems that are dispersed geographically and exposed to severe environmental conditions.

The T2D2 Lab maintains expertise in electronics and mechanical design, fabrication and software engineering, thus enabling quick development projects ranging from specialized cables to large-scale jamming systems.

The T2D2 Lab's engineers hold eight U.S. patents.

GTM (Figure 4) was developed to aid the test officer in verifying the presence of RF signals in a dynamic test environment. It can be used in conjunction with a set of emitters, presenting a time-ordered list of emissions in a distributed field test environment. The GTM uses Global Positioning System (GPS) timing to synchronize its collection events with the transmitters to ensure that each emitter is transmitting on cue. GPS timing that is accurate to 20 milliseconds is enabled by the use of a commercial-off-the-shelf (COTS) GPS receiver, the Garmin Model 35, as well as the T2D2-Lab-developed GPS Pulse Per Second Adapter.



Figure 4. Ground Truth Monitor (GTM) System

The GTM allows the operator to view the spectrum, in real time, as it is being collected and analyzed. The graphical user interface also provides the user with easy control of the system, instant feedback on the performance of the emitter vans and a view of the data that are being logged.



Figure 3. The T2D2 Lab in the Electromagnetic Environmental Test Facility

The GTM's Starship Interface Server enables Starship to remotely control all of the GTM functions. This permits a single point of control and monitoring of the test environment generation (the emitter vans) and the GTM. The GTM provides real-time feedback (to Starship) of the status of each emitter in the scenario, thereby increasing the test officer's control of the test environment.

As a follow-on to the development of the Autonomous Wireless Sensor System, the GTM software was developed rapidly, and many of the components were re-used. The main effort involved adding the ability to synchronize the data collection with the remote signal generation equipment using GPS as the timing source. The GTM uses a COTS spectrum analyzer to sample the RF spectrum. The spectrum analyzer uses the Universal Serial Bus (USB) to communicate with the host computer. The high speed of the USB 2.0 interface enables the GTM software to collect several complete spectrum traces each second.

The GTM employs a novel spectrum processing to average the noise over these traces, measure the noise floor and "peak up" the signals that may not be present for the entire sample duration. The GTM then uses a peak search algorithm to find all peaks in the sample bandwidth. The GTM records time and signal parameters for each of the peaks found in an Excel-readable log file. Also reported are the summary statistics, which indicate how many of the emitters were found and how many were above a certain threshold above the noise floor.

The T2D2 Lab is in the planning stage for a next-generation GTM system. It will enable the collection at multiple system-under-test locations, as well as collection at the emitter locations. The system will use an encrypted wireless radio system and will be controlled by Starship. □

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